

A
POPULAR LECTURE
ON THE
ASTRONOMY and PHILOSOPHY
OF
COMETS.

IN WHICH,
The Opinions of the ANTIENTS,
AND THE
Discoveries of Sir ISAAC NEWTON,
Relative to those Bodies, are introduced and explained.

BY SAMUEL DUNN,
Master of an Academy at CHELSEA.

*Read to some of the AUTHOR's Pupils, unacquainted with
the more intricate Parts of speculative Mathematics.*

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OF

COMMITTEE

IN
The Opinion of the

Committee of the

BY SAMUEL DORR
Member of an Honorable

And of the

1840

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NEW YORK

T O

Stephen Demainbray, *L. L. D.*

Teacher of PHILOSOPHY

To His ROYAL HIGHNESS

The PRINCE of WALES;

AND

PRINCE EDWARD,

This Tract,

Is most humbly Inscribed.

TO

Stephen Demainbray, A.L.D.

Teacher of Philosophy

TO HIS ROYAL HIGHNESS

THE PRINCE OF WALES;

AND

PRINCE EDWARD,

THE

Is now being printed.



A
POPULAR LECTURE

ON THE
ASTRONOMY and PHILOSOPHY

O F
C O M E T S.

1. **A** COMET is a blazing Star, which begins to appear at a certain Place in the Heavens, where it hath not been expected nor observed, moves with an irregular Motion from Day to Day among the fixed Stars, sometimes remains stationary, and at last disappears.

2. The Parts of which a *Comet* is apparently composed, are, its *Nucleus* or Head, its *Coma*, Beard or hairy Matter furrounding its *Nucleus*; and its fiery or blazing *Tail*, which
B some-

sometimes extends to a great Length and considerable Breadth in the Heavens, making a disagreeable Appearance in a dark Night when the Sky is clear.

3. Of such Comets, or blazing Stars, as have already been observed in Ages past, some have appeared *round*, and therefore have been compared to a bright *Shield*. Others have been observed to be like an *Oval* flattened at its Ends. Others so as to have been compared to the *Tail* or *Mane* of a *Horse*. Others to burning *Lamps* or *Torches*. Others to *flaming Swords*. Others to *Darts* or *Javelins*. Others to hilted *Cimeters*. Others to *Lances*. With Diversity of Colours, some of the colour of *Silver*, others of *Gold* or *Amber*, others of *Blood*; &c. from all which Appearances, these strange Phenomena have been taken for the direful Omens of impending Evils, shortly to ensue, near such Places where they have been seen.

4. But, notwithstanding these Superstitions of the Vulgar in all Ages and Countries, there have not been wanting a few among the Philosophers of the most ancient Times, who have had Sagacity enough,

nough, by the Assistance of Science, to consider these Phænomena, as Bodies rightly disposed, and under due Regulations in the System of Nature.

5. Of these were ^a PYTHAGORAS and his Followers, who held Comets to be a kind of Planets, which after having been detained a long Time, in going thro' a determinate Circuit, came at last to appear again. ^b DEMOCRITUS supposed them to be Stars more irregular than the five Planets. The ^c *Chaldeans* reckoned Comets among the Planets, and that the one had certain Periods or Courses like the other. ^d APPOLLONIUS TYANEUS used to say, that Comets were celestial Bodies, whose Courses lead them to higher Parts of the World, and then to lower, where they came to appear; but their Courses he did not know. ^e SENECA did not think Comets to be sudden Fires, but of the eternal Works of Nature; and therefore there

^a Flourished about 600 Years before Christ. Born at *Samos*. Settled at *Crotona* in *Italy*.

^b Flourished about 450 Years before Christ, at *Abdera* in *Thrace*.

^c Inhabitants near *Babylon*.

^d Flourished about 90 Years after Christ, at *Rome*.

^e Flourished about 60 Years after Christ. Born at *Corduba* in *Spain*. He taught at *Rome*.

there ought to be a Collection of former Appearances of them ; because, by reason of their feldom appearing, their Courfes could not yet be understood ; nor could it otherwise be difcovered, whether they return or no, or that they appear and are produced in Order, at their fettled Time. One Age (*faith he*) is not fufficient to make fuch great Discoveries. Yet thefe Things, which are now hid, will at laft be brought to Light, by Length of Time and the Diligence of Pofterity. Somebody will demonftrate which Way Comets wander ; why they go fo far from the reft of the celeftial Bodies ; how big ; and what Sort of Bodies they are. And thofe, that come after, will wonder that we were ignorant of Things fo plain.

6. But, notwithstanding thefe moft pertinent Predictions, ^f ARISTOTLE and his Followers, afferting that Comets were but *Vapours* and *Exhalations* fet on Fire in the higher Regions of the Air or Atmosphere, and that their *Tails* were thin *Vapours* arifing from their *Heads*, and diverfified according to the Property of the Matter that feeds their
Flame :

^f Flourifhed about 350 Years before Chrift. Born at *Stagyra* in *Macedonia*.

Flame: This Opinion prevailed until the noble ^s TYCHO BRAHE, ^h KEPLAR, and a few others, by making actual Observations of their Places among the *fixed Stars*, found them without sensible *Parallaxes*, and far above the Orbit of the *Moon*.

7. These Observations may be said to have made a Beginning in the *Astronomy of Comets*, and distinguished them as a Kind of Bodies taking ample Ranges thro' the vast Regions of Space. Whilst their Traces, and the Cause of their strange Appearance, were Subjects too difficult for the Philosophers of those Times. And therefore the best Solutions given, concerning them for the most Part, still amounted to but probable Conjecture.

8. Hence KEPLAR concluded, that Comets were formed by a Commotion of Atoms in the Abyss of liquid Æther; and that, by the Stimulation of the Sun-beams, they became illuminated, inflamed, and set in Motion, thro' the Heavens like shooting Stars. ⁱ HEVELIUS
sup-

^s A Danish Nobleman, 1572.

^h Flourished 1620. Born at *Wittemberg* in Germany, and Mathematician to three Emperors.

ⁱ Flourished at *Dantzick* 1670.

supposed them to be certain *Disks*, or congregated Vapours, generated from the Atmospheres, and more subtil Exhalations of Planets, accidentally approaching toward each other. And that, acquiring a spiral Revolution round such Planets where they have been formed, by the intestine Heat of the same, they are at last thrown off, and approach in *parabolical Lines* toward the Sun. ^k DES CARTES supposed, the Bodies of Comets formed of the Remains of certain fixed Stars, such as having been first covered with *Maculæ*, or Spots, at length become incapable of emitting Light, and are carried away with approaching Vortexes, 'till they come near the Sun, where they are vehemently heated and appear. ^l CASSINI concludes, that Comets are, for the most Part, confined to a certain Tract or Space among the fixed Stars; and, having observed or compared many of them, found their apparent Courses between ^m *Antinous, Pegasus, Andromeda, Taurus, Orion, Canis Minor, Hydrus, Centaurus, Scorpio*, and the Bow of *Sagittarius*; which Space

* Flourished 1640. Born in Britany in France, was in the Army, retired to a little Village near Egmond in Holland, and studied 25 Years.

^l Flourished at Paris 1680.

^m Constellations in the Heavens.

Space in the Heavens, he therefore calls the *Cometary Zone*; and suspects, that they return, either containing the Earth in their Orbits, or otherwise, so that the Convexity of their Orbits may be turned towards the Earth.

"BERNOUILLI, conceiving the Sun to be in the Middle of a Vortex, as a great Fire kindled in a Hearth, and by whose Heat the Planets round him are warmed, so that a great Quantity of subtil Exhalations comes out of the Planets every Way, and even from the Sun itself; supposes, that by the rapid Motion of the solar Vortex, such Exhalations from the Sun are carried toward the Surfaces of the Planets, where they are stopped and repelled by the planetary Exhalations, forming a Viscuous Maculæ on the Surfaces of the Planets, like Soot in the Side of a Chimney. Hence, supposing a certain primary Planet to revolve about the Sun at the Distance of 200,000,000000 Miles, with various secondary Planets moving round it in Orbits very excentric; such a primary Planet may be invisible to a Spectator on our Earth, its secondary Planets may be Comets, visible in *Peregæum*, and so heated in their nearest Approaches to the Sun, as to form blazing-Stars.

9. APIAN,

1682, at *Basil*.

9. APIAN, CARDAN, GALLILEO, TYCHO BRAHE, SNELLIUS, HEVELIUS, DES CARTES, and some others, have supposed the Tails of Comets to be produced by the Passage of the Sun's Beams thro' the Comets or their Atmospheres, and that by Reflection or Refraction of those Beams from the same, the Tails are formed. But this Supposition seems to have no Foundation in Optics. KEPLAR supposes the Beams of the Sun to pass strait thro' the Nucleus and gross Matter of which the Comet is composed, and that a certain Quantity of the cometary Matter itself is carried therewith to the opposite Side from the Sun, forming a fiery Stream. And BERNOUILLI concludes, that if the Tail of a Comet should intermingle with our Atmosphere, or its Matter should fall on our Earth, it may induce Changes in the Air that may be very sensible among animal and vegetable Bodies.

10. But, notwithstanding these and many other ingenious Conjectures, stamp'd with antient and venerable Authorities, the Works of many Ages, the select Geniusses of foreign Parts, and a solid Foundation of the Sciences having been long since laid, there seems to have been produced no unexceptionable Account

count of these Phænomena until ° NEWTON : who, perceiving that many of his Predecessors had not used a Method of Reasoning adequate to the Phænomena of Nature, but introduced many whimsical Notions of their own, such as would not stand the Test of Mathematical Scrutiny ; assumed more rational Maxims, correspondent with the first apparent Properties of natural Bodies, and by a very cautious and nice Examination of the various Powers of Nature however combined, deduced, *à priori*, a Multiplicity of Truths, relative to the Sun and Stars, Planets, Comets, &c. which otherwise probably would never have been known, nor supposed, had not the most accurate Observations from the Beginning of those Discoveries, to the present Time, been exactly conformable with the Theory advanced.

II. This excellent Genius, having attentively considered the Properties of Bodies, and observed, that from the Tops of the highest Mountains, to the Depths of the deepest Vallies, and below, *Matter*, however modelled, modified or engaged, is never without a natural Propension and Endeavour to descend freely toward the Centre of the Earth's Globe ;

• Born in *Lancashire*. Published his Discoveries 1686.

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and having found, by accurate Experiments, that the Quantity of such Propension and Endeavour is every where near the Earth's Surface, directly proportional to the Quantity of Matter, be its Figure or Density what it will; first supposes it as not improbable, but that the great Globes of the Planets themselves, may have the same natural Propension toward each other, with Powers also proportional to their Quantities of Matter respectively, and hence become regulated by the same Law.

12. Indeed the industrious and sagacious *Keplar*, had gone so far, as to determine, from accurate Observations, that the Planets were all carried round the Sun in *elliptical Orbits*, one *Focus* of those Ellipses being the Place of the Sun as at *Rest*, and that the *Areas* of the *elliptic Sectors*, formed between *Radii* drawn from the Sun, to an *elliptical Arch* of the Orbit itself, were directly proportional to the Times in which the Planets were carried over the same elliptic Arches themselves. And the same excellent Astronomer had also discovered, that in all the planetary Motions the Squares of the periodic Times were directly proportional to the Cubes of their mean Distances from the Sun; that is, as the Square of the Time which one Planet takes in revolving

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ing round the Sun, to the Cube of its mean Distance from the Sun; so is the Square of the periodic Time which another Planet takes in revolving round the Sun, to the Cube of its mean Distance from the Sun. But then *Des Cartes* had established a Notion of the Heavens as being filled with a *fluid Medium* or *subtil Matter*, and asserted the Rapidity of it to be such as kept up the Motions of the Celestial Bodies: And, therefore, notwithstanding the Discoveries which *Keplar* had made, which for aught any Body then knew, might be as well accounted for by the Hypothesis of *Des Cartes*, as any other, it was no easy Matter, under such Circumstances, to make a right Determination. Notwithstanding which Difficulty, our Philosopher perceives no Occasion for such a Medium as *Des Cartes* had supposed, nor any Possibility of a very lasting Motion of the planetary Bodies among themselves, unless such a Medium be exceedingly rare, or void of all sensible Resistance, and by Consequence of all sensible Matter itself.

13. These seem to have been all the Hints which *Newton* could possibly have received from antient Times, or those of his own, without himself. And with these he boldly

enters the Field of Contemplation, and proceeds, by the ^p Keys of the Sciences, determining what will naturally be the last Results, when Bodies are put in Motion, and actuated by presupposed Laws. In which arduous Researches he deduces a Multitude of Precepts, which for their Aptitude and Simplicity are such, as to denominate them the most faithful Explications of natural Phænomena.

14. From these Solutions only, we came to understand why the *Circumsaturnal Planets* by Radii drawn to *Saturn's* Centre, describe Areas proportional to the Times of Description, and why their periodic Times (the fixed Stars being at Rest) are in the sesquiplicate Proportion of their Distances from its Centre.

15. Why the *Circumjovial Planets*, by Radii drawn to *Jupiter's* Centre, describe Areas proportional to the Times of Description; and why their periodic Times (the fixed Stars being at Rest) are in the sesquiplicate Proportion of their Distances from its Centre.

16. Why the periodic Times of the five primary Planets, *Saturn*, *Jupiter*, *Mars*, the

^p Synthetical and analytical Investigation.

Earth,

Earth, Venus and Mercury, are in the sesquiplicate Proportion of their mean Distances from the Sun, the fixed Stars being at Rest.

17. Why the *primary Planets* by Radii drawn to the Sun, describe Areas proportional to the Times of Description. And,

18. Why the *Moon* by Radii drawn to the Earth's Centre, describes Areas proportional to the Time of Description.

19. That the Forces, by which the *circumjovial Planets* are continually drawn from rectilinear Motions, and retained in their Orbits, tend to *Jupiter's* Centre, and are *inversely* as the Squares of the Distances of the Places of those Planets from that Centre. And that the same Law holds with the *Circumsaturnals* as with the *Circumjovials*.

20. That the Forces by which the *primary Planets* are continually drawn off from *rectilinear Motions*, and retained in their Orbits, tend to the *Sun*, and are *inversely* as the Squares of the Distances of the Places of those Planets from the Sun's Centre.

21. That

21. That the Force by which the *Moon* is retained in its Orbit, tends to the *Earth*; and is *inversely* as the *Square* of the Distance of its Place from the Earth's Centre.

22. That the *Moon* gravitates toward the *Earth*, and by the Force of Gravity is continually drawn off from a rectilinear Motion, and retained in its Orbit.

23. That the *circumjovial* Planets gravitate toward *Jupiter*, the *circumsaturnals* toward *Saturn*, the *Circumsolar* toward the *Sun*, and by the Forces of their Gravity, are drawn off from rectilinear Motions, and retained in curvilinear Orbits.

24. That *all* Bodies gravitate toward *every* Planet, and that the *Weights* of Bodies toward *any* the *same* Planet, at *equal* Distances from the Centre of the Planet, are proportional to the *Quantities* of Matter which they severally contain.

25. That there is a Power of Gravity tending to *all* Bodies, proportional to the several *Quantities* of Matter which they contain.

26. That

26. That the celestial Spheres mutually gravitating each toward the other (the Matter in Places on all Sides round about, and equidistant from the Centres being similar) the *Weight* of those Spheres toward each other, is inversely as the *Squares* of the Distances between their Centres.

27. That the Force of Gravity considered downward from the Surfaces of the Planets, *decreaseth* nearly in the Proportion of the Distances from their Centres.

28. That the Motions of the Planets in the Heavens may subsist an *exceeding* long Time : And that the Planet *Jupiter* alone, loseth not the $\frac{1}{1,000,000}$ th Part of its Motion in 1,000,000 Years.

29. That the *Centre* of the System of the World is immovable. And that the *common Centre* of Gravity of the *Earth*, the *Sun* and all the Planets, is *immovable* also.

30. That the *Sun* is agitated by a perpetual Motion, but never recedes far from the common Centre of Gravity of all the Planets.

31. That

31. That the *Planets* cannot but move in *Ellipses*, which have their common *Focus* in the Centre of the Sun, and by *Radii* drawn to that Centre they must necessarily describe *Areas* proportional to the *Times* of Description.

32. That the *Aphelions* and *Nodes* of the *Orbits* of the *Planets* are fixed.

33. What *Proportion* necessarily settles the *transverse Diameters* of the *Orbits* of the *Planets* ; and what the *Excentricities* and *Aphelions*.

34. That the *diurnal Motions* of the *Planets* are uniform, and the *Moon's Libration* arises from its *Diurnal Motion*.

35. That the *Axes* of the *Planets* are *shorter* than the *Diameters* drawn perpendicular to the *Axes* ; and what *Proportion* must necessarily subsist between those *Axes* in the several planetary *Bodies*.

36. That the *Weights* of *Bodies*, Bulk for Bulk, are *different* from each other at different *Places* on the *Earth's Surface* ; and that they
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are *inversely* as the distances of those Bodies from the Earth's Centre.

37. That the *equinoctial Points* go backward, and that the Earth's Axis by a *Nutation* in every annual Revolution, twice vibrates toward the *Ecliptic*, and as often returns to its former Position.

38. That all the Motions of the Moon, and all the Inequalities of those Motions, follow from the Gravitation of the Moon toward the Earth.

39. That the unequal Motions of the Moon in its Orbit, and the unequal Motions of the Satellites in their Orbits, are analogous to each other.

40. That the *flux* and *reflux* of the Sea arise from the Actions of the Sun and Moon.

41. What the Forces are with which the Sun disturbs the Motions of the Moon.

42. What is the (1) Force of the Sun to move the Sea.

(1) $\frac{1}{12868200}$ th Part of the Force of Gravity.

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43. What

43. What is the (^r) Force of the *Moon* to move the *Sea*.

44. What is the Figure of the *Moon's* Body.

45. What occasions the *Precession* of the *Equinoxes*, and what the (^s) Quantity of such *Precession* must be.

46. What kind of Bodies *Comets* are, and what Ranges they take in the Celestial Spaces.

47. That the *Comets* move in some of the *Conic Sections*, having their Foci in the Center of the *Sun*, and by Radii drawn to the *Sun*, describe Areas proportional to the Times.

48. That from several Places of a *Comet* observed in the Heavens, the *Dimensions* of its Orbit may be found.

49. That whatever Laws are observed in the *planetary System*, the same Laws are also observed in the *cometary System*.

50. That

(^r) $\frac{1}{2871400}$ th Part of the Force of Gravity.

(^s) $9'' \ 7''' \ 20''''$ occasioned by the *Sun*, and
 $40'' \ 52''' \ 52''''$ occasioned by the *Moon*.

$50'' \ 0''' \ 12''''$ yearly by both.

50. That the Opinion of DES CARTES and his Followers concerning a fluid Medium, subtil Matter, and Vortexes, cannot be true ; because upon a Supposition that they are true, both Planets and Comets must necessarily be directed by quite different Laws than what would make their Phænomena correspond with actual Observations.

51. Such Truths, the genuine Productions of Reason and Judgment, founded on the surest Maxims of moral Certainty, noble in themselves, beneficial to all, universally explicating Nature's various Appearances, and so much the more illustrious, as with greater Care they are observed and found to be the best Interpreters of Nature and its Laws ; may justly perpetuate a modest Fame of their Discoverer to Posterity, and excite others to Diligence and Industry, until no more Discoveries are reserved for the Glory of succeeding Ages.

52. These philosophical Discoveries enable us to understand, that if our Earth move the same Way in its Orbit, with the Comet in its Orbit, and swifter in Appearance to an Eye at the Sun, than the Comet's Motion the same Way, in such Case the Comet will every Day

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recede

recede from the Sun, and is therefore said to be *retrograde*, or moving contrary to the order of the Signs; but otherwise *direct*, or moving with the Order of the Signs.

53. That the *Nuclei* of Comets receive their Light from the Sun, in like Manner as the Planets do: That when they disappear they are much below the Orbit of *Jupiter*; and in their Perihelions come nearer to the Sun than the Orbit of *Mars*.

54. That the *periodic Times* of the Comets, to the periodic Times of the Planets, are directly in the sesquialteral Ratio of the Transverse Axes of the Comets, to the Transverse Axes of the Planets respectively.

55. That the *Nuclei* of Comets are solid, compact, and (†) durable *Bodies*, like those of the Planets and our Earth: And that otherwise in their Approaches to the Sun, they would

(†) Sir *Isaac Newton* computes the Surface of the Comet of 1680 to have acquired a Degree of Heat 28000 times greater than that of our Midsummer-Day; or near 2000 times the Heat of a red-hot Iron; and that a Globe of Iron, of the Dimensions of our Earth, so intensely heated, would not be cold in 50000 years: And that this Comet itself, so heated quite thro', would not be cold in 2000 years. Its periodic Time being about 575 Years; the Length of its Tail 80 Million Miles, and Motion near its Perihelion 15000 Miles in a Minute of Time.

would be dissipated and wholly dispersed in Vapour and Fume.

56. That the Tails of Comets are longest and largest soon after they have past their Perihelions, or made their nearest Approaches to the Sun : And that the Matter of which those Tails are composed is a Kind of Smoak or hot Vapour emitted from the Nuclei of the Comets, when they are overmuch heated by the Solar Rays : And that on Account of the greater Density of the ætherial Medium toward the solar Surface, and the incessant Expulsion of Rays from the Sun's Disk, the rarified Matter of which the Tails of Comets are formed, must be always in the Directions of the Planes of the cometary Orbits themselves, and opposite to the Sun.

57. That altho' the Tails of Comets would be strait, was there nothing but the Stimulus of the Sun Beams rarifying their Nuclei and Atmospheres, yet those Tails cannot always appear *strait* to a Spectator on our Earth : When they are extended to a very great Length in the celestial Spaces, and a Spectator is removed from the Planes, in which the Comets themselves are.

58 That

58. That as in our Air, the Smoak of a heated Body ascends either perpendicularly if the Body is at rest, or obliquely if the Body is moved obliquely ; so in the Heavens, where all Bodies gravitate toward the Sun, Smoak and Vapour must ascend from toward the Sun, and either rise *perpendicularly* if the smoaking Body is at Rest, or *obliquely* if the Body by its Motion is continually leaving those Places from which the higher Parts of the projected Vapours had arisen.

59. That this Obliquity must be least near the *Nuclei* of Comets, and greatest near the Ends of their Tails ; because at the former of these Places the accelerated Vapour is discharged with its whole Impetus, and at the latter it is reduced by an irregular Diminution to nothing, whereas nothing of this kind can preserve the Appearance of a strait Line, and therefore the ascending Vapour, of which the Tails are formed, must in some Situations and Circumstances appear incurvated, and of different Forms.

60. That it is very possible there may arise from the mere *Atmospheres* of Comets Vapour enough to produce all the Phænomena of their
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their Tails, is self-evident from the Expansion of our Air when its circumambient Pressure is taken away, or its Rarity is computed for a considerable Height about the Surface of the Earth's Globe, its Density upward decreasing so fast as to leave no Reason for the least Resistance perceptible, even no higher than the lunar Regions : And therefore as the Comets seldom come near the planetary Atmospheres, but move in Spaces void of all sensible Resistance, the Vapours discharged by them, whilst they are capable of reflecting or refracting Light, may be said to be projected in free Spaces.

68. That the Tails of Comets cannot but be extremely *rare*, because the Light of the smallest *Stars* is not prevented from passing freely thro' them ; whereas the Light of Stars of the first Magnitude, is wholly intercepted and destroyed by intervening Flame, Light, Smoak, Steam, Clouds, and Vapours. *Jupiter's* Satellites cannot be seen near its Body before the Rays are taken away ; the Light of the Moon diminishes the Lustre of both Stars and Planets, and therefore, there can be no Grounds for supposing the Tails of Comets a less rarified Vapour.

62. Hence the Tails of Comets, their Matter considered as already discharged from the Nuclei, seem to participate of the Nature of that Light which forms the *Aurora Borealis*, or steady Illumination sometimes perceived in our Atmosphere in a clear Evening without *Moonshine*; or the Splendor with which a Beam of Light appears when reflected from minute Particles of Dust, swimming in a dark Room; or the *Twilight* by Reflection and Refraction of the Sun Beams; or the heterogeneous Matter of which the Earth's Atmosphere is composed: Of substance similar to that of the Planets themselves, and to that of our Earth; abundantly reflecting Light without dividing its Rays; abounding partly with active, and partly with passive Principles; the grosser Parts gravitating towards the Nuclei, the rarer dissipating and wholly dissolving in the ætherial Medium, vanishing away, and at last, by little and little, gravitating toward the Planets themselves, and intermingling with their Atmospheres.

63. The principal Danger then which the Inhabitants of the Earth's Globe seem to stand in with Respect to the Tails of Comets, may possibly be founded on the Density of true permanent Air surrounding the Nuclei: For

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as Fire dies away without a constant Supply of Air to feed its Flame, and heated Air becomes more powerful by the Action of the solar Rays; so true permanent Air compressing in the Atmospheres of Comets may inclose a subterraneous Warmth and Heat in them; and in their nearest Access to the Sun the same permanent Air may become a kind of heated transparent Vapour, not wholly unlike the Atmosphere of our torrid Zone, or transparent Vapours near the Surface of burning Coals without Flame, or solar Rays collected into a Focus by the burning Glass.

64. Such an effervescent transparent Medium, formed partly by a Discharge of condensed Air from within the Nuclei of Comets, and partly arising from the Impetus of the solar Rays upon their dense Atmospheres, may therefore be most like true elementary Fire on those Sides of the Nuclei which are toward the Sun. And therefore whether Comets turn round their Axes or not, such Matter will not be projected to any great Length otherwise than in a Direction opposite to the Sun. For the Resistance that Way is insensible, on account of the great Rarity of the ætherial Medium; whereas toward the Sun,

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the Gravitation of Atoms and Expulsion of Rays, must form a more dense Medium. And because the Nuclei toward the Sun appear most compact, the Tails may be lucid Fumes, like those of Phosphorus in a dark Room when the Pressure of the external Air is taken away by a Receiver.

65. The Force or Intensity of elementary Fire (if any) as discharged from the Nuclei of Comets seems to bear no sensible Proportion to the Force of the solar Rays obtruding it. For the Nuclei on all sides as well toward the Sun as otherwise, appear no worse defined than the Planets would, if they were inveloped with deeper Atmospheres of the same Kind. And therefore there can be no sensible Heat at the Extremities of the Atmospheres of Comets arising from their Nuclei.

66. The Intensity of Heat with which a Comet is at any Time heated, may be estimated as that of the " Planets at their nearest Distances from the Sun. And the Effect which such Heat can produce in animal Bodies may be deduced by a Comparison of the

" The Heat of the Sun at the Orbit of Mercury is 7 Times the Heat of the Sun at the Orbit of our Earth.

Heat

Heat under the Equator with that^w near the Poles of our Earth. And hence an * Estimation may be made of the Consequences, if ever our Earth should happen to be involved in a Comet's Tail or its Atmosphere. Nor doth it appear that any other Powers appertain to the Tails of Comets or their Atmospheres.

^w The Heat of the Sun under the Equinoctial Line, the Sun being in the Equator, is near 6 Times the Heat of the Sun at *Greenland*, in Lat. 80° , the Sun being on the Meridian.

* The Heat of the Sun at the solar Surface is 45000 Times the Heat at the Equinoctial of our Earth.

The Heat of the Comet of 1680, near its Perihelion, was 28000 Times the Heat with us at Midsummer, according to Sir *Isaac Newton*.

If that Comet had passed near the Earth at the Distance of 50 Miles from the Earth's Surface, its Heat might have been 12 Times that of our Midsummer Heat, or near the Heat of red hot Iron. Had the same Comet passed by us at the Distance of 150 Miles, its Heat might have been nearly the Heat of our Summer. Had it passed at the Distance of the Northern Part of *Scotland* from *London*, its Heat might have been a 10th Part of our Midsummer Heat. At the Distance of a Semi-diameter from the Earth the 500th Part of Midsummer Heat. At greater Distances nothing perceptible. And therefore as there is but little Probability that Comets may come so near the Earth, the less Danger may be apprehended from the Approaches of their Tails and Atmospheres.

67. That the Nuclei are composed of Matter more compact and solid than that of their Tails and Atmospheres, appears from their Reflection of Light like that from the Planets. That those Nuclei may possibly come near the Earth, is manifest from their Courses under all Directions thro' the solar System. And that it is possible they may make a Collision with the Planets as they move, seems to admit of but little Dispute. Yet since the solar Rays are reflected from Surfaces without touching them. The same Magnet attracts at one Distance and propels at another. The same reflective Substance subsists in a manifold Degree on the Surfaces of the Planets. Our Earth abounds with magnetical Matter, and probably the Planets do so too. A Percussion of the celestial Bodies might cause a Cessation of some of their Motions; and the Equipoise of the whole System might be thereby partly destroyed or shaken. Why may not the Divine Architect have left Nature abundantly provided with Remedies sufficient against those apparent Dangers?

The

*The principal TECHNICAL TERMS,
&c. in the foregoing LECTURE,
explained.*

ATOMS. Smallest Parts of which Bodies
are composed.

Æther. A Fluid more thin than Air, diffused
throughout all Space where Body is not.

Atmosphere. The Air which we breathe; its
Height above the Earth's Surface, about 50
Miles.

Apogæum. Place of a Planet when farthest
from the Earth.

Area. Face or Surface, be it flat or uneven.

Axis. A straight Line, drawn thro' a Planet,
from Pole to Pole.

Air. An invifible transparent Fluid, the chief
Support of animal Life.

Aurora Borealis. Northern Light.

Convex. Bending from a Centre.

Concave. Bending to a Centre.

Cube. 3 Times 3 is 9, and 3 Times 9 is 27,
which is the Cube of 3. 4 Times 4 is 16,
and 4 Times 16 is 64, which is the Cube
of 4. The like is to be understood for
other Numbers.

Cir-

Circumsaturnals. Saturn's Moons or Satellites.

Circumjovials. Jupiter's Moons or Satellites.

Circumsolars. Primary Planets.

Curvilinear. Crooked.

Celestial. Belonging to the Heavens.

Centre. A Point in the Middle or otherwise, where it is respected by Bodies moving round it.

Condensed. More close, compact, or confined.

Collision. Clashing, dashing.

Diurnal. Daily.

Dense. Close, compact, solid.

Ellipsis. A Figure which may be represented by holding a round Ring upright, and letting it project a roundish Shadow on a Plain.

Earth. The Globe on whose Surface we dwell, its Compass round, about 25,000 Miles.

Ecliptic. Apparent Path of the Sun among the fixed Stars, for a Year.

Equator. Great Circle equally distant from both Poles.

Equinoctial Points. Two Points in the Heavens where the Equator cuts the Ecliptic.

Effervescence. Great Struggling of the Parts of a Fluid among themselves.

Fixed Stars. Those twinkling Lights which deck the Firmament in a clear Evening.
Probably

Probably they are Sun's, and their nearest Distance 30,00000,00000 Miles.

Focus. One of the Centres of an Ellipsis.

Globe. A round Body.

Gravitation. The Endeavour of Body to move to some Center.

Inversely. Contrarily.

Impetus. Force.

Intensity. Greatness.

Maculæ. Dark Spots on the Face of the Sun, which probably are floating Drofs on liquid Fire.

Maxims. Principles true by general Consent.

Matter. Body, Substance perceived by the Senses.

Medium. A transparent Fluid.

Magnet. Load-stone.

Node. Place of a Planet where it crosseth the Plain of the Earth's Orbit.

Nutation. Nodding.

Orbit. Path of a Planet or Comet.

Oblique. Slanting.

Parallax. Difference between the true and apparent Place of a Planet among the fixed Stars.

Phænomenon. Appearance.

Parabolical Line. Such as is described by a Body tossed slanting.

Planets Primary. Mercury, Venus, our Earth, Mars, Jupiter and Saturn.

Planets Secondary. The Moon moving round our Earth, Jupiter's 4 Satellites, and Saturn's 5 Satellites.

Peregræum. Place of a Planet when nearest the Earth.

Perehelion. Place of a Planet nearest the Sun.

Reflection. Turning aside.

Refraction. Splitting or dividing the Rays of Light, when they pass from one Medium to another.

Radius. A strait Line drawn from a Centre to its Arch-line.

Rectilinear. Right-lined.

Reciprocally. Contrarily.

Retrograde. Backward or contrarily to the yearly Course of the Sun, with respect to the fixed Stars.

Ratio. Rate or Proportion.

Rare. Open, spungy, wide.

Rays. Balls of Fire or Light, inconceivably small, and coming from the Sun at the Rate of 10,00000 Miles in a Minute of Time.

Spiral. A Line like that described by a Bowl on a Bowling-green.

Sector. The Space contained between two Radii and an Arch-line.

square.

Square. The Product of a Number multiplied by itself.

Sesquiplicate. As the Squares of the one to the Cubes of the other.

Sphere. Globe.

Satellites. Moons or Secondary Planets.

Sesquialteral. As the Square of the one to the Cube of the other.

Transverse. Longest strait Line, that can be drawn in an Ellipsis.

Vortex. A Whirlpool of fluid Matter.

Zone. A Girdle or Belt.

F I N I S.



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